Selection of Project Procurement Methods in the Consumer Electronics Industry - a Hong Kong Study

ABSTRACT

Under pressure from both the ever increasing level of market competition and the global financial crisis, clients in consumer electronics (CE) industry are keen to understand how to choose the most appropriate procurement method and hence to improve their competitiveness. Four rounds of Delphi questionnaire survey were conducted with 12 experts in order to identify the most appropriate procurement method in the Hong Kong CE industry. Five key selection criteria in the CE industry are highlighted, including product quality, capability, price competition, flexibility and speed. This study also revealed that product quality was found to be the most important criteria for the “First type used commercially” and “Major functional improvements” projects. As for “Minor functional improvements” projects, price competition was the most crucial factor to be considered during the PP selection. These research findings provide owners with useful insights to select the procurement strategies.

Keywords: Project procurement, consumer electronics, Delphi method, Hong Kong

1. INTRODUCTION

The future of the Hong Kong consumer electronics (CE) industry is full of uncertainties because it is facing many challenges from mainland China and worldwide, which include ongoing changes of the Chinese regulatory system, rising labor costs, stricter environmental protection requirements, growing protectionist sentiment in the U.S. and European Union (Wong, 2007), and global financial tsunami in 2009. This is reflected in the sharp decrease of the total Audio-Visual Equipment exports growth rate from 34% to -5% from 2004 to 2008 (HKTDC, 2007; HKTDC, 2008; HKTDC, 2009). The total exports of Hong Kong AV equipment increased by 12% in 2010 and then fell by 3% during the first two quarters in 2011 (HKTDC 2011).

In Hong Kong, most electronics companies (over 98%) are small and medium-sized enterprises (SMEs) (HKTDC, 2011). In addition, many CE projects have relatively small scale and short development cycle, i.e. from less than 2 months up to 9 months (HKEIA, 2004). Under the increasing level of threats from external competition, it is imperative for CE companies to utilize resources effectively. Project procurement (PP) method is used to define how the design, development and manufacturing are acquired. A range of procurement strategies are currently utilized in the Hong Kong CE industry, such as: In-house Design and Construct (IDC), In-house Design and Develop (IDD), Design separated from Construction (DsfC), Novation Contract (NC), Design and Construct (DC), Design and Develop by Consultant (DDC) and Off-shelf Sourcing (OS). It is crucial for clients to choose the most appropriate procurement strategy as different choice may affect the final project performance (Eriksson and Westerberg, 2011; Heidemann and Gehbauer 2011). Furthermore, given the volatile market nowadays, clients are becoming more cautious with regards to the selection of PP methods.

However, it is striking to note that there are very limited studies focusing on project procurement in consumer electronics industry. Moreover, the majority of PP studies in the CE industry focus on the perspectives of suppliers rather than clients. Clients in the CE industry are keen to understand how to choose procurement methods and hence to improve their competitiveness. This study, therefore, aimed to set up a framework to facilitate clients selecting the most appropriate PP method in the Hong Kong CE industry by employing the Delphi method with a group of experts. Since the Audio/ Visual (A/V) equipments play a major contribution to the Hong Kong CE industry, the research particularly focuses on project procurement of A/V products.

2. LITERATURE REVIEW

2.1 The consumer electronics industry

The value of the global consumer electronics industry reached $253.7 billion in 2009, which is forecasted to increase 14.1% in 2014 (Datamonitor 2011). Consumer electronics is very diverse and has very broad product categories in entertainment, communications and home/office equipments. Take the entertainment equipments for example; consumer electronics in this category include a variety of audio and visual products, such as TV, DVD, media player – iPod & MP3, and portable radio that serve to entertain the consumers. The common characteristics of CE industry are:

- Ever-falling prices (Trout & Rivkin 2009; Carpenter & Balija 2010).
- The market is highly volatile (Appelqvist & Gubi 2005; Tanaka 2011).
- The ‘traditional’ old products such as cassette tape recorder, portable CD are being phased out rapidly.
- The new product development cycle is short since the product life is much shorter in

the market (Kaipia and Holmstrom, 2007; Tachizawa and Thomsen, 2007).

- It requires manufacturers with capability of flexibility (Helo, 2004), advanced and sophisticated tools and techniques.
- The projects are commonly of high risks (Sodhi and Lee, 2007; Janse et al. 2010).

All CE products inevitably suffer from continual price erosion owing to market competition (Choi and Nailer, 2005; Gulati 2010). Improved manufacturing ramp-up capacity and technology evolution help reduce the cost, and innovated products firstly launched to the market may generally enjoy the highest profit margin. With upgraded living standards, the consumers are continuously increasing their expectations on product requirements such as quality, features and design.

2.2 Project procurement

Project procurement (PP) is defined by the Project Management Institute as: "the processes to purchase or acquire the products, services, or results needed from outside the project team to perform the work" (PMI 2008, p.313). According to Banomyong and Supatn (2011), procurement forms a critical component of supply chain management. The management of project procurement essentially places focuses on the rationality of procurement, the scope of the works, the selection of suppliers, and the execution process of procurement. Similarly, sharing information effectively helps to improve the operational and financial performance, and in turn enhance the supply chain performance (Kamel et al. 2011). In particular, integration of suppliers is crucial for new product developments in the manufacturing sector so that the procurement performance is improved (Smith 2011).

In the CE industry, any new product requires three major steps prior to launching into the

market, including product design (Design), Development, and Manufacture. Product design creates the outlook and appearance of the product, which plays a vital role in initially attracting consumers. A good product design should not only be aesthetically pleasant but also technically feasible in manufacturing. Development requires the combined efforts of mechanical and electrical engineers to create the tool drawings, tooling, working samples as well as to test for validation and reliability prior to mass production (manufacturing). These three major steps are not necessarily discrete (Lawson, 1992). Instead, all parties should be involved as early as possible. Furthermore, new electronics product can be broadly grouped by complexity as 'First type used commercially', 'Major functional improvements' and 'Minor functional improvements' that have different development time spans (HKEIA, 2004). 'First type used commercially' is the innovated products that are firstly launched into the market. 'Major functional improvements' is the running model with newly added important features. 'Minor functional improvements' could be software upgrade, newly added features or improvement in the outlook design.

PP methods in CE industry are related to how Design, Development and Manufacture of CE products are procured to enhance the project success. Clients in the Hong Kong CE industry are increasingly adopting Original Design Manufacture (ODM) and Original Brand Manufacture (OBM) other than the Original Equipment Manufacture (OEM) (Lam, 2002; Davis, 2008). Furthermore, they even use a mixture of OEM, ODM and OBM business for diversification (Lam, 2002). The OEM, ODM and OBM businesses can be decomposed and classified into seven PP methods embracing all possible combinations in terms of Design, Develop and Manufacture (see Figure 1). Each PP method is developed to meet a varying set of circumstances with inherent advantages and disadvantages (Xia and Chan, 2008).

Figure 1 here

There are numerous studies on the criteria or guidelines of selecting a PP system/ method in the construction industry (Alhazmi and McCaffer, 2000; Chan, 2007; Cheung et al., 2001; Smith, 2008). A set of common selection criteria is shown in Table 1. These criteria relate to various aspects of the project, such as the scope, time, cost, quality, risk, technical and relationship. In addition, the majority of project procurement studies in the construction context place emphasis on the client's objectives.

In the CE industry however, there are very limited studies on the selection of project procurement. Research studies in the CE industry are largely related to the logistics supply chain management concerning the material procurement and logistics (Liemt, 2007). Moreover, the majority of PP studies in the CE industry focus on the perspective of OEM and ODM suppliers rather than clients (see Table 1). Table 1 shows the previous studies of the project procurement in both construction and CE sectors. Considering the different interests from clients and suppliers in the selection of PP methods, the research is aimed at setting up a selection framework of PP methods for clients in the CE industry.

Table 1 here

3. RESEARCH METHODOLOGY

The Delphi method is a powerful technique which is appropriate for arriving at objective opinions among a group of experts (Chan et al. 2001). It is a data gathering process through progressive questionnaire surveys in multiple rounds that a consensus of opinion is reached by consultation with the experts (Manoliadis et al., 2009). The Delphi study is featured with

anonymity which helps to minimize dominant bias and allows experts to express their own opinions freely (Hallowell and Gambatese 2010). Consensus is obtained among the contractual parties with conflicting interests. According to Ludwig (1997), the majority of Delphi studies have used between 15-20 respondents. Moreover, with a homogeneous group of experts, reliable results can be obtained even with a panel as small as 10-15 individuals (Ziglio, 1996).

3.1 Selection of Delphi Experts

According to Chan et al. (2001), the selection of the expert panel determined the success of Delphi method. Hallowell and Gambatese (2010) pointed out that 8-12 experts will be sufficient for a rigorous Delphi study. In the current study, 12 experts from both the client and supplier sectors agreed to participate in the Delphi questionnaire survey. The background information of these experts is shown in Table 2.

Table 2 here

Table 3 here

Table 3 shows the working years of Delphi experts in the Hong Kong CE industry. All the experts are experienced practitioners playing various managerial roles (marketing, project management, technical specialist and product design) in PP process. The experts were selected equal in number from the clients and suppliers in order to reflect the opinions of the two major stakeholder groups on PP selection. The experts' sufficient working experience in CE industry and sound knowledge of PP methods enhance the validity of this Delphi research.

3.2 Development of Delphi Questionnaires

The most important issue in this process is the understanding of the aim of the Delphi exercise by all experts so that high level of response and consensus can be achieved (Yeung et al., 2007). Otherwise the experts may answer inappropriately or become frustrated and lose interest. In the current study, experts were briefed on the background of this research before the Delphi study. Similarly, a full description of terminologies was provided so that experts share the same definition and understanding of these terminologies.

Before the official launch of the Delphi study, a pilot survey was conducted to test and adjust the Delphi questionnaire in a bid to improve comprehension, work out any procedural problems, and minimize the confusion of the requirement that might have occurred (Skulmoski et al., 2007). The pilot study was carried out with 7 experts, including academics and practitioners, in the first instance to ensure that the questions are clear to respondents, meaning the same thing to each person and they were able to answer them. The result was satisfactory, therefore no changes were made.

After that, four rounds of Delphi questionnaire survey were conducted with the twelve experts. In round 1, the experts were asked to select at least five most important criteria for the selection of PP methods used in the Hong Kong CE industry. The common criteria identified during the literature review (Table 3) were provided for their reference. They were also encouraged to provide other criteria according to their own experience and knowledge. In round 2, the experts were requested to reconsider the selection criteria in the light of the consolidated results from round 1, and then score each PP method against each criterion based on 5-point Likert scale system. In Round 3, experts were asked to reconsider the ratings of the selection criteria in the light of the results from round 2, and then weight the importance of each criterion by pair-wise comparison against three generic types of project development for innovated products. The purpose of Round 4 was to get the final consensus

among the experts. The experts were presented with the scores obtained from round 2 and 3, and requested to reconfirm their ratings to the selection criteria. The structure of the four rounds questionnaire survey is illustrated in Figure 2.

The questionnaires in each round are as follows:

Questionnaire 1: Please list at least five most important selection criteria for PP selection.

Questionnaire 2: Please reconsider the selection criteria and give rating to each PP method against selection criteria according to their importance.

Questionnaire 3: Please weight the importance to the selection criteria, by pair-wise comparison, against the three generic types of project development for CE products

Questionnaire 4: Please reconsider the ratings to the PP methods against selection criteria and project types in the light of the results from round 2 and round 3.

According to Skulmoski et al. (2007), key features of Delphi method are: (1) Anonymity of Delphi participants; (2) Iteration; (3) Controlled feedback; and (4) Statistical aggregation of group response. These features are designed to minimize the biasing effects of dominant individuals, irrelevant communications, and group pressure toward conformity. The current Delphi study was organized in accordance with the above four features in order to achieve a consensus opinion among the Delphi experts.

Figure 2 here

3.3 Analysis Methods

Weighted factor scoring model and Analytical Hierarchy Process (AHP) using pair-wise comparisons were used for data analysis in the Delphi process.

Weighted factor scoring model

To calculate the total score of each PP method with regards to the three generic types of projects, the Round Two result - the average score (s_i) of each PP method- and the Round Three result - the average weight (w_i) of each criterion are used in the following equation, by weighted factor scoring model. The total score of a PP method is obtained by the following equation:

$$S = \sum_{i=1}^{n} s_i w_i$$

Where

S = total score of a PP method;

s_i = average score of a PP method on i*th* criterion;

w_i = percent of total weight for the i*th* criterion.

$\sum_{i=1}^{n} w_i = 1$ and for this research, n = 5

There are several techniques available to generate the average score s_i and the weight w_i, but the most effective and widely used method is the Delphi technique. In the Round One, a set of common criteria is identified to judge the selection of a PP method. In the Round Two, the average score s_i of a PP method on each criterion is determined. Then, the relative importance (the weight w_i) of each criterion against the three generic types of projects is obtained using AHP pair-wise comparison in the Round Three. Using the above equation, the total score of each PP method can be calculated and the results are presented in the Round Four. Finally, the consensus should be reached and the most appropriate PP method(s) are determined.

Analytical Hierarchy Process (AHP) using pair-wise comparisons

Developed by Saaty in 1980s, AHP aids decision marking where a group of experts can structure a problem into a multi-level hierarchy (Al-Harbi 2001). Using their expertise and knowledge, the group of experts can solve the problem (e.g. determining the relative importance of selection criteria) by implementing the steps of analytical hierarchy process (Mahdi and Alreshaid 2005). AHP hierarchy includes three levels in the current study. The top level is the goal of selecting the most appropriate PP method for a certain project type. The second level is about selection criteria and the lowest level is about the options of PP methods. The weights of criteria were determined objectively by comparing any pair of the criteria. The structure of the AHP hierarchy for the selection of PP methods is shown in Figure 3.

Figure 3 here

4. FOUR ROUNDS OF DELPHI SURVEY: RESULTS AND ANALYSIS

4.1 Round One – Highest Rated Criteria

The experts were requested to select a minimum of five criteria from the literature (listed in Table 1) that were believed as the most important criteria to select the PP methods in the Hong Kong CE industry. In addition, they were encouraged to propose other criteria according to their knowledge and working experience. Table 4 and Figure 4 indicate that the criteria with more than or equal to 50% selection are Product quality, Capability, Price competition, Flexibility and Speed. Product quality and Capability are the highest rated criteria with 83% selection, while the market driven factor - Sales channel was not selected by any experts. The five criteria identified would be used for scoring each PP method in Round Two questionnaire. The results were in accordance with the author's expectation. As

there are a lot of criteria (total 30) from the literature for selection, it is the authors' concern of occurrence of the following two scenarios:

i) Too many criteria ≥ 50% selection

Theoretically, the criteria should not be limited to five but in practical terms, more than five criteria would lengthen the subsequent questionnaires that the experts may be reluctant to continue participation.

ii) Too few criteria ≥ 50% selection

Inconsistency of experts' selection causes invalid result.

The above two worst scenarios did not happen. As there are five criteria ≥ 50% selection from the Round One questionnaire, the subsequent questionnaire were conducted without adjustment. The back-up plan of adding one more round questionnaire for getting the consensus from the experts on criteria selection was not required.

Table 4 here

4.2 Round Two – Score of Each PP Method

The experts were requested to score each PP method against each criterion within the range 1-5 based on the consolidated results from Round 1 Questionnaire survey. Additionally, they were allowed to list other criteria and gave their ratings. All twelve experts agreed that the five highest rated criteria with ≥ 50% selection identified in Round One were appropriate for scoring each PP method as nobody selected the other criteria for scoring. The average score of each PP method is shown in Table 6. This result will be reviewed in final Round Four.

Table 5 here

As shown in Table 5, In-house Design and Construct and In-House Design and Develop got the highest score for Product quality while Off-shelf Sourcing got the highest score for Price competition and Speed.

4.3 Round Three and Four - Total Score of Each PP Method/Most Appropriate PP Method

In Round 3, the experts were requested to weight the importance of each criterion against three generic types of project development within the range 1 – 5 by comparing the pair of criteria. In Round 4, the results from Round 2 and Round 3 were presented, reviewed and finalized. The most appropriate PP method was then identified.

Table 6 here

As shown in Table 6, the most important criteria for 'First type used commercially/Major functional improvements' and 'Minor functional improvements' are Product quality and Price competition respectively. Figure 6 reveals a trend of PP selection from complex to simple project development that Product quality, Capability and Flexibility are decreasingly important while Price competition and Speed are increasingly important.

In comparison with the Round 3 results, Round 4 has very similar results and the exceptions are just the Novation Contract (NC) and Design and Construct (DC) which the ranks are interchanged in 'Major functional improvements' and 'Minor functional improvements'.

Figure 5 here

Tables 7-9 described the final score of all available project procurement methods in each type of consumer electronics project. As shown in Figure 5, Design and separated from Construction (DsfC), ranking the number one for all three generic types of project development, is the most appropriate PP method identified using the Delphi technique in this research study. It reveals that the clients prefer doing own product design and subcontract project development and manufacturing to the OEM supplier. The traditional PP method of Design separated from Construction (DsfC) still plays an important role in the Hong Kong CE industry as one key success factor in CE market is the product design that the clients wants to have full control of aesthetic requirements such as the brand identity. With own design, clients can be proactive in selling and get more potential customers worldwide. By procurement of development and manufacturing works, the clients can reduce staffing as around the world, large electronics companies are trying to downsize by outsourcing (Liemt, 2007). While Off-shelf Sourcing (OS) ranks the lowest in 'First type used commercially' and 'Major functional improvements', it ranks the second highest in 'Minor functional improvements'. It possibly reveals that the clients prefer Price competition and Speed for commodity products that are offered by Off-shelf Sourcing (OS). Similarly, In-house Design and Construct (IDD) ranks the second highest for all three generic project types in the Hong Kong CE industry. Under adverse marketplace conditions that the market demand is low, OS is suitable for procuring commodity products such as clock radios that the market supply is abundant and new tooling is not cost justified. Design and Develop by Consultant (DDC) is the least appropriate PP method as it ranks the second lowest in first two types and the lowest in last type. It seems that the clients do not prefer the design consultant to subcontract manufacture to the third party supplier as the price competition is reduced.

Figure 5 also reveals the following trends:

First type used commercially

With IDC, IDD, DsfC and NC dominating the top ranks reveal that the clients prefer OBM and OEM procurement rather than ODM for complex projects with high asset specificity. The clients keep their core competencies including own design or development/ manufacturing and subcontract the other works to the suppliers. This result is in line with HKEIA (2004, p.6) that most Hong Kong electronics SMEs (about 70%) are engaged in OEM business, which DsfC is apparently the most popular type according to this study. Gradual drop from DsfC to NC and then OS possibly reveals that the clients do not need ODM suppliers doing all the works for 'First type used commercially' which usually allows longer time for them to be involved on project development.

Major functional improvements

It is not surprised that the trend is very similar to 'First type used commercially' except NC and DC are interchanged in rank. For 'Major functional improvements' with shorter development time, the clients may require the ODM suppliers to take up the whole project at design phase using DC. Project can be speeded up by fast tracking of design and development.

Minor functional improvements

Compared to 'Major functional improvements', OS jumps to the second highest. For 'Minor functional improvements', Price competition and Speed are the dominant factors (refer to the Table 6) that OS is the best method according to the Table 9.

Table 7 here

Table 8 here

Table 9 here

Managerial implications

According to the Delphi study results of this research, a guideline is developed to assist the determination of the most appropriate project procurement method in the consumer electronics industry (Figure 6). This method combines both qualitative and quantitative approaches of project procurement selection.

Figure 6 here

The project charter is the document that formally authorizes a project (PMI, 2008, p.73). The project charter, usually issued by the project owner, should at least address the following information for facilitating PP method selection in the CE industry:

- Product requirements, at least preliminary, including key features and critical success factors such as excellent sound quality and unique trendy design
- Marketplace competition including rival model(s) for benchmarking
- Market model strategies and asset specificity
- Internal constraints including capability and capacity
- External constraints including regional regulatory approvals (safety/hazardous materials), license/royalty issues and sales exclusivity
- Product plan including product life and roadmap of preceding and succeeding models
- Preliminary schedule including target 1st shipment date and quantity
- Budgets including target development costs, tooling and unit prices

Once the project charter is issued, key project stakeholders responsible for making PP decisions (e.g. project owner, project manager and product/marketing manager) should hold an internal project kick-off meeting for brainstorming so that all team members share the same understanding of the product requirements and project characteristics. Within the framework of the project charter, criteria are identified for the selection of PP method in the consumer electronics industry such as:

- Scope – Flexibility, Project scope
- Time – Speed, Time certainty, Schedule
- Cost - Price certainty, Price competition, Funding constraints, Value for money, Profit
- Quality - Product quality, Aesthetics
- Risk - Risk allocation, Risk management
- Technical - Complexity, Availability, Innovation, Capability
- Relationship - Responsibility, Arbitration and disputes, Familiarity of the system, Supplier type
- Market - Sales channel, Market competition, Sales volume, Product range
- Others – Internal resources, Reduce client staffing, Client's involvement, Supplier's involvement

To avoid bias and autocratic behavior, all team members should be allowed to freely express their opinions that must be considered equally. The next step is to score each PP method with weighted criteria by means of weighted factor scoring model and Analytical Hierarchy Process (AHP) using pair-wise comparisons. As a result, the most appropriate PP method for the consumer electronics industry is determined.

5. DISCUSSIONS AND CONCLUSION

Project procurement (PP) method is used to define how the design, development and manufacturing are acquired. Scarce resources, volatile demand, shorter product life cycles, and tougher global competitions force the CE clients to make accurate decision of selecting a PP method in order to survive (Moynihan et al., 2006). The selection of an appropriate PP method would enhance the project success.

A four-round Delphi questionnaire survey was employed in this study in order to identify the most appropriate PP method in the consumer electronics industry. It serves as a self-validating mechanism and provides a valuable framework for tapping experts' knowledge. Twelve industry experts participated in this research. Their positions are diversified, which include program manager, managing director, mechanical specialist, project manager, marketing manager and design director. Five key selection criteria were arrived at the end of four rounds of Delphi survey. These criteria are: Product quality, Capability, Price competition, Flexibility and Speed.

Product quality is the most important criterion for the 'First type used commercially' and 'Major functional improvements' projects and the third most important criterion for 'Minor functional improvements' projects. According to Valia (2003), the increasing product complexity is the driver for the increasing importance of product quality due to the uncertainty of the customer expectations. Longer warranty periods may induce higher cost for after-sales service that forces the clients and suppliers to pay more attention on improving the product quality. Outsourcing combined with globalization/segmentation of business processes involving people from internal and external organizations require more complex communication not under direct control and may hamper the product quality. Reduction in

‘time to market’ for CE products shortens the project development time and may trigger higher risk of potential quality problems.

Supplier’s capability of doing own design, development and manufacturing is another crucial criterion to be considered. It is the second most important criterion for ‘First type used commercially’ and ‘Major functional improvements’ projects. Clients select the suppliers for new innovated product development since the highly competitive electronics industry demands that suppliers provide low-cost, high-quality products to their customers in a timely fashion (Mason et.al, 2002).

Price competition is the most important criterion for ‘Minor functional improvements’ and the least important criterion for ‘First type used commercially’. The negative correlation between the product complexity and the importance of price competition is in line with common market model strategies. For commodity products such as clock radios that are abundant in supply in the market, the client can easily procure them at the lowest costs by price competition.

It is imperative to consider the flexibility of changes required after development works are started to meet client’s needs. Flexibility is equally important for ‘First type used commercially’ and ‘Major functional improvements’ while it is the least important criterion for ‘Minor functional improvements. When there is technology gap for complex project such as ‘First type used commercially’ that the scope of product technical specifications cannot be clearly defined at the project initiation, the client would likely prefer a PP method that allows flexibility of changes after project development is started. The volatile CE market (Silker, 2006) requires manufacturers with capability of flexibility (Helo, 2004) to meet ever

increasing clients' expectations on the product requirements in terms of quality, features and design. Small to Medium Enterprises (SMEs) are generally believed to have greater flexibility of responding more rapidly to customer needs and changing market conditions (McIntyre, 2009). In Hong Kong, almost 98% of electronics companies are SMEs (HKTDC, 2008). They are flexible on PP management such as changing scope to meet the price target and planned shipment day.

Speed refers to the importance of project delivered on time to the success of the project. It is the second most important criterion for 'Minor functional improvements' and the second least important criterion for 'First type used commercially'. CE product life is much shorter (Kaipia and Holmstrom, 2007; Tachizawa and Thomsen, 2007). In the electronics industry, speed is a key to customer satisfaction and its competitiveness (Folgo, 2008). Companies are trying to shorten the development time (Jafari et.al, 2010).

The most important criteria for 'First type used commercially/Major functional improvements' and 'Minor functional improvements' are Product quality and Price competition respectively. There is a trend of PP selection from complex to simple project development that Product quality, Capability and Flexibility are less important while Price competition and Speed are increasingly important.

Five key criteria for the selection of procurement method in the electronics industry have been identified in this study through a comprehensive literature review and four-round Delphi survey. The research findings provide a useful reference to the clients to choose the most appropriate project procurement method for various types of product developments under the increasing level of market competition and the pressure of global economic turbulence.

This research also revealed that the weighting of these five criteria varies according to the type of project. Therefore, the selection of most appropriate project procurement will need to take the type of project into consideration. According to this research, Design and separated from Construction (DsfC) was considered by all Delphi study experts as the most appropriate project procurement methods for all three generic types of project development in the CE industry. This is significantly different from the existing research in other industries such as the construction industry where a trend is shown that the integrated procurement approach is merging. It seems that the clients in the consumer electronics industry prefer to provide the design and then engage the OEM supplier to develop and manufacture the product. By contrast, the Design and Develop by Consultant (DDC) is the least appropriate PP method across three generic types of project developments.

The limitation of this study is influenced by the limited number of experts involved in this study and the subjectivity or bias involved, which are common problems in opinion-based research. Employees in Hong Kong usually work long (average 49.6 hours weekly in 2008) and late into the evenings (Welford, 2008). Many practitioners in the Hong Kong consumer electronics industry work and even stay in mainland China. Hence, it is very difficult to invite a large number of experts. Future research opportunities exist to conduct an industry wide survey to validate the theory developed in this study. Similarly, case studies can be undertaken to investigate how these selection criteria have been implemented in the selection of project procurement in the consumer electronics industry. Finally, an international benchmarking study can be conducted to compare the leading practice with the practice in the Hong Kong context.

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REFERENCES

Al-Harbi, K.M.A. (2001) 'Application of the AHP in project management', *International Journal of Project Management*, Vol.19, No.1, pp.19-27.

Alhazmi, T. and McCaffer, R. (2000) 'Project Procurement System Selection Model', *J. Constr. Engrg. and Mgmt*., vol. 126, no. 3, pp. 176-184.

Appelqvist, P., Gubi, E. (2005) 'Postponed variety creation: case study in consumer electronics retail', *International Journal of Retail & Distribution Management*, Vol. 33 No.10, pp.734-48.

Baker, M. and Lambert, J. (2003) *Crisis in prices*, International Council of Shopping Centers, Accessed on 18 Dec. 2007, available at http://www.icsc.org/srch/sct/sct0903/page77.php.

Banomyong, R. & Supatn, N. (2011) 'Supply chain assessment tool development in Thailand: an SME perspective', *Int. J. Procurement Management*, Vol. 4, No. 3, pp. 244-258.

Carpenter, J.M. & Balija, V. (2010) 'Retail format choice in the US consumer electronics market', *International Journal of Retail & Distribution Management*, Vol. 38, No. 4, pp. 258 – 274.

Chan, A. P. C. , Yung, E. H. K. , Lam, P. T. I. , Tam, C. M. and Cheung, S. O. (2001) 'Application of Delphi method in selection of procurement systems for construction projects', *Construction Management and Economics*, Vol. 19, No.7, pp. 699-718.

Chan, C.T.W. (2007) 'Fuzzy procurement selection model for construction projects',

Construction Management and Economics, vol. 25, no. 6, pp. 611-618.

Cheung, S.O., Lam, T.I., Leung M.Y. and Wan, Y.W. (2001) 'An analytical hierarchy process based procurement selection method', *Construction Management and Economics*, vol. 19, no. 4, pp. 427-437.

Choi, C.J. and Nailer, C. (2005) 'The China market and European companies', *European Business Review*, vol. 17, no. 2, pp. 177-190.

Datamonitor (2011) *Consumer Electronics: Global Industry Guide 2010*, Datamonitor.

Davis C., (2008) *Charging Ahead, Product Magazines: Product Trends*, Accessed on 17 Feb 2009, available at http://info.hktdc.com/prodmag/enterpri/ ent200808IndustryOverview. htm#1.

Eriksson, P.E. and Westerberg, M. (2011) 'Effects of cooperative procurement procedures on construction project performance: A conceptual framework', *International Journal of Project Management*, Vol.29, No.2, pp.197-208.

Fantazy, K.A., Kumar, V. & Kumar, U. (2011) 'The impact of information sharing on supply chain performance: an empirical study', *International Journal of Procurement Management*, Vol. 4, No. 3, pp. 274-296.

Folgo, E.J. (2008) *Accelerating Time-to-Market in the Global Electronics Industry*, MBA and MSc thesis, Massachusetts Institute of Technology.

Gulati, R. (2010) *Reorganize for resilience: Putting customers at the center of your business*, Harvard Business Press.

Hashim, M., Li, M.C.Y., Chan, Y.L.M., Ng, C.Y., Ng, S.H., Shim, M.H. and Tay, L.Y. (2006) 'Factors influencing the selection of procurement systems by clients', Paper presented at *International Conference on Construction Industry 2006*, Padang, Indonesia, 21st – 25th

June 2006.

Heidemann, A., and Gehbauer, F. (2011) 'The way towards cooperative project delivery', *Journal of Financial Management of Property and Construction,* Vol. 16, No. 1, pp.19 – 30.

Helo, P. (2004) 'Managing agility and productivity in the electronics industry', *Industrial Management & Data Systems*, vol. 104, no. 7, pp. 567-577.

HKEIA (2004) *From OEM to ODM*, The Hong Kong Electronic Industries Association, Hong Kong.

HKTDC (2011) *Audio-visual Equipment Industry in Hong Kong*, accessed on July 2011, available at http://www.hktdc.com/info/mi/a/hkip/en/1X004000/1/Hong-Kong-Industry-Profiles/Audio-Visual-Equipment-Industry-In-Hong-Kong.htm.

HKTDC (2007) *Economic & Trade Information on Hong Kong*, accessed on 17 Dec 2007, available at http://www.tdctrade.com/main/economic.htm.

HKTDC (2008) Audio-visual equipment 12 Feb 2008, *Market Intelligence*, accessed on 23 Apr. 2008, available at http://www.electronics.tdctrade.com.

HKTDC (2009) Audio-visual equipment 7 Sep 2009, *Market Intelligence*, accessed on 14 Sep 2009, available at http://www.hktdc.com/info/vp/a/elec/en/1/2/1/1X004000/Electronics-Electricals/Audio-visual-Equipment.htm.

Jafari, M.M., Ahmed, S., Dawal, S.Z.M. and Zayandehroodi, H. (2010) The Effects of Electronic Collaboration in Reducing Production Time: Product Design Process in SMEs, *Proceedings of the International MultiConference of Engineers and Computer Scientists* 2010, March 17-19, Hong Kong, vol. 3. Accessed on July 2011, available at http://www.iaeng.org/publication/IMECS2010/IMECS2010_pp1868-1872.pdf

Janse, B., Schuur, P. & de Brito, M. (2010) 'A reverse logistics diagnostic tool: the case of the consumer electronics industry', *The International Journal of Advanced Manufacturing Technology*, Vol. 47, No. 5-8, pp.495-513.

JCT (2008) Deciding *on the appropriate JCT contract. Practice Note*, the Joint Contracts Tribunal Ltd., Sweet & Maxwell Limited, London.

Kaipia, R. and Holmstrom, J. (2007) 'Selecting the right planning approach for a product', *Supply Chain Management: An International Journal*, vol. 12, no.1, pp. 3-13.

Kenig, M., Stelljes, D., Williams, C., Holland, J., Nawrocki, R. and Peed, K. (2003) *Selecting the Appropriate Project Delivery Option*, Georgia State Financing and Investment Commission, Georgia.

Lam, H. (2002) *Value Creation through Process/Project Management: Product Developer and Marketer's Perspective*, accessed on 15 Feb. 2009, available at http://www.ahkea.org/content/events/YYU-PM.pdf

Lau, A.K.W. and Yam, R.C.M. (2005) 'A Case study of product modularization on supply chain design and coordination in Hong Kong and China', *Journal of Manufacturing Technology Management*, Vol. 16, No. 4, pp. 432-446.

Lawson, M. (1992) 'Electronic product design and manufacture in a concurrent engineering environment. Consumer Electronics', *IEEE Transactions*, Vol. 38, No. 3, pp. 666 – 670.

Liemt, G.V. (2007) Subcontracting in electronics: From contract manufacturers to providers of Electronic Manufacturing Services (EMS), *SECTORAL ACTIVITIES PROGRAMME Working Paper, WP.249*, accessed on 11 Jan. 2008, available at http://www.ilo.org/public/english/dialogue/sector/papers/tem-mee/wp249.pdf

Love, P.E.D., Skitmore, M. and Earl, G. (1998) 'Selecting a suitable procurement method for a building project', *Construction Management and Economics*, Vol. 16, No. 2, pp. 221-233.

Ludwig, B. (1997) 'Predicting the future: Have you considered using Delphi methodology?', *Journal of Extension*, Vol. 35, No. 5, pp 1-4.

Lui, K.M.R. (2004) *OEM to ODM/OBM Development In Consumer Electronics Manufacturing Industry In Hong Kong*, MBA thesis, Pao Yue-kong Library PolyU, Hong Kong.

Luu, D.T., Ng, S.T. and Chen, S.E. (2003) 'Parameters governing the selection of procurement system – an empirical survey', *Engineering, Construction and Architectural Management*, Vol. 10, No. 3, pp. 209-218.

Mahdi, I.M. and Alreshaid, K. (2005) 'Decision support system for selecting the proper project delivery method using analytical hierarchy process (AHP)', *International Journal of Project Management*, Vo.23, No.7, pp 564-572.

Mahdi, I.M., Riley, M.J., Fereig, S.M. and Alex, A.P. (2002) 'A multi-criteria approach to contractor selection. Engineering', *Construction and Architectural Management*, Vol. 9, No.1, pp. 29-37.

Manoliadis, Odysseus George , Pantouvakis, John-Paris and Christodoulou, Symeon E. (2009) 'Improving qualifications-based selection by use of the fuzzy Delphi method', *Construction Management and Economics*, Vol. 27, No. 4, pp 373 -384.

Mason, S.J., Cole, M.H., Ulrey, B.T. and Yan, L. (2002) 'Improving electronics manufacturing supply chain agility through outsourcing', *International Journal of Physical Distribution & Logistics Management*, Vol. 32, No. 7, pp. 610-620.

Matthew R. Hallowell and John A. Gambatese (2010) 'Qualitative Research: Application of the Delphi Method to CEM Research', *Journal of Construction Engineering and Management*, Vol. 136, No. 1, pp. 99-107.

McIntyre, J. (2009) *Enhancing the SME NPD Process through Customer Focused Design*

Activities: A New Zealand Case Study, accessed on 29 May 2009, available at http:// muir.massey.ac.nz/bitstream/10179/1073/1/02whole.pdf

Moynihan, G.P., Saxena, P. and Fonseca, D.J. (2006) 'Development of a decision support system for procurement operations', *Int. J. Logistics Systems and Management*, Vol. 2, No. 1, pp. 1-18.

Ng, S.E., Luu, D.T., Chen, S.E. and Lam, K.C. (2002) 'Fuzzy membership functions of procurement selection criteria', *Construction Management; Economics*, Vol. 20, No. 3, pp. 285-296.

PMI (2008) *PMBOK Guide*, fourth edition, Project Management Institute, Inc., Pennsylvania

Rashid, R.A., Taib, I.M., Ahmad, W.B.W., Nasid, M.A., Ali, W.N.W. and Zainordin, Z.M. (2006) *Effect Of Procurement Systems On The Performance Of Construction Projects*, Universiti Teknologi Malaysia, accessed on 6 Jan. 2008, available at http://eprints.utm.my/790/1/Procurement_performanceRosli.pdf.

Ratnasabapathy, S. and Rameezdeen, R. (2006) 'A Multiple Decisive Factor Model for Construction Procurement System Selection', *The construction and building research conference of the Royal Institution of Chartered Surveyors* at University College London, The RICS, London.

Skulmoski, G.J., Hartman, F.T. and Krahn, J. (2007) 'The Delphi Method for Graduate Research', *Journal of Information Technology Education*, vol. 6, pp. 1-21. Available at http://jite.org/documents/Vol6/JITEv6p001-021Skulmoski212.pdf

Smith, A.D. (2011) 'Successfully managing manufacturing supplier integration and procurement issues: case studies in recessionary environments', *International Journal of Procurement Management*, Vol.4, No. 2, pp. 121-138.

Smith, A.D. and Offodile, O.F. (2008) 'Strategic importance of team integration issues in

product development processes to improve manufacturability', *Team Performance Management*, Vol. 14, No. 5/6, pp. 269-292.

Smith, J., Zheng, B., Love, P.E.D. and Edwards, D.J. (2004) 'Procurement of construction facilities in Guangdong Province, China: factors influencing the choice of procurement method', *Facilities*, Vol. 22, No. 5/6, pp. 141-148.

Smith, V.R.R. (2008) *Impact to alternative contracting methods using multivariate analysis in the regulatory environment*, PhD thesis, Georgia Institute of Technology.

Sodhi, M.S. and Lee, S. (2007) 'An analysis of sources of risk in the consumer electronics industry', *Journal of the Operational Research Society*, Vol. 58, No. 51, pp. 1430-1439.

Tachizawa, E.M. and Thomsen, C.G. (2007) 'Drivers and sources of supply flexibility: an exploratory study', *Internal Journal of Operations & Production Management*, Vol. 27, No. 10, pp. 1115-1136.

Tanaka, K. (2011) 'Product demand risk management model based on empirical forecasting: consumer electronics product case', *International Journal of Revenue Management*, Vol. 5, No. 2-3, pp. 221 – 233.

Trout, J. & Rivkin, S. (2009) *Repositioning: marketing in an era of competition, change, and crisis*, McGraw-Hill Professional.

Valia, T.P. (2003) *An Analysis Of Field Feedback In Consumer Electronics Industry*, Technische Universiteit, Eindhoven.

Wong, A. (2007) *Hong Kong's Trade Outlook 2007: Moderation in exports amid heightened policy risks*, Hong Kong Trade Development Council, Hong Kong.

Wong, W.H.F., Pam, T.I.P. and Chan, P.C.A. (2004) 'Procurement Approaches To Achieve Better Constructability', *The international construction research conference of the Royal*

Institution of Chartered Surveyors, Leeds Metropolitan University, Leeds.

Xia B., and Chan A.P.C. (2008) 'The investigation of design-build variants in the construction market of the People's Republic of China', *First International Conference on Construction in Developing Countries (ICCIDC-1),* August 4-5, 2008, Karachi, Pakistan.

Ziglio, E. (1996) *The Delphi method and its contribution to decision making, Gazing into the oracle: The Delphi method and its application to social policy and public health*, Jessica Kingsley Publisher, London.

Table 1: Common selection criteria for PP methods

Common Selection criteria for PP methods	Construction industry									CE industry							
	Chan et al. (2001)	Hashim et al. (2006)	JCT (2008)	Kenig et al. (2003)	Love et al. (1998)	Luu et al. (2003)	Mahdi et al. (2003)	Ng et al. (2002)	Rashid et al. (2006)	Rat. and Ram. (2006)	Smith (2008)	Smith et al. (2004)	Wong et al. (2004)	HKEIA (2004)	HKTDC (2008)	Lau and Yam (2005)	Lui (2004)
Scope																	
Flexibility	√	√	√	√	√		√	√		√		√	√				√
Project scope	√	√		√		√							√				
Time																	
Speed	√	√	√		√	√	√	√	√	√	√	√	√				√
Time certainty	√		√		√	√				√		√	√				
Schedule			√	√													
Cost																	
Price certainty	√	√	√		√				√	√	√	√	√				
Price competition	√	√			√	√		√	√	√		√	√				√
Funding constraints				√			√										
Value for money		√				√											
Profit														√	√		
Quality																	
Product quality		√			√		√	√	√	√	√	√			√		√
Aesthetics						√			√								
Risk																	
Risk allocation		√	√		√	√	√	√				√					
Risk management	√					√				√			√				
Technical																	
Complexity	√	√	√		√	√	√	√		√		√	√				
Availability	√		√			√				√			√				
Innovation																	√
Capability																	√

Table 1: Common selection criteria for PP methods (continued)

Common selection criteria for PP methods	Construction industry									CE industry							
	Chan et al. (2001)	Hashim et al. (2006)	JCT (2008)	Kenig et al. (2003)	Love et al. (1998)	Luu et al. (2003)	Mahdi et al. (2003)	Ng et al. (2002)	Rashid et al. (2006)	Rat. and Ram. (2006)	Smith (2008)	Smith et al. (2004)	Wong et al. (2004)	HKEIA (2004)	HKTDC (2008)	Lau and Yam (2005)	Lui (2004)
Relationship																	
Responsibility	√	√	√		√			√		√		√	√				
Arbitration and disputes					√							√					
Familiarity of the system	√	√								√			√				
Supplier type			√													√	
Market																	
Sales channel														√	√		
Market competition														√	√		
Sales volume														√			
Product range														√			
Others																	
Internal resources				√		√											
Reduce client staffing																	
Client's involvement							√				√						
Supplier's involvement																	

Table 2: Background information of the experts

Experts code	Job title	Client/ Supplier
E1	Marketing manager	Supplier
E2	Project manager	Supplier
E3	Project manager	Supplier
E4	Program manager	Supplier
E5	Project manager	Supplier
E6	Mechanical specialist	Supplier
E7	Marketing manager	Client
E8	Managing director	Client
E9	Project manager	Client
E10	Mechanical specialist	Client
E11	Design director	Client
E12	Marketing manager	Client
Total experts: 12	All experts are holding senior positions in their organizations.	Experts from Client:6 Experts from Supplier:6

Table 3 Respondent classifications by years working in CE industry

Experts code	Years of experience in CE industry	Number of PP projects involved
E1	21	70
E2	14	50
E3	12	25
E4	11	20
E5	13	55
E6	13	55
E7	18	100
E8	16	90
E9	14	50
E10	16	55
E11	14	55
E12	11	60
Mean	14.4	57

Table 4: Round One – Rates of selection on the criteria

Common criteria of PP selection	Experts from client (1)	Experts from supplier (2)	Total experts. (3)=(1)+(2)	Frequency	Rank
Product quality	6	4	10	83>50	1
Capability	4	6	10	83>50	1
Price competition	3	6	9	75>50	3
Flexibility	3	3	6	50=50	4
Speed	2	4	6	50=50	4
Time certainty	2	3	5	41.7	6
Risk management	3	2	5	41.7	6
Supplier's involvement	3	2	5	41.7	6
Schedule	1	3	4	33.3	9
Price certainty	2	2	4	33.3	9
Innovation	3	1	4	33.3	9
Supplier type	2	2	4	33.3	9
Value for money	2	1	3	25	13
Risk allocation	2	1	3	25	13
Sales volume	1	2	3	25	13
Client's involvement	2	1	3	25	13
Complexity	2	1	3	25	13
Internal resources	1	2	3	25	13
Project scope	2	0	2	16.7	19
Profit	1	1	2	16.7	19
Funding constraints	1	0	1	8.3	21
Aesthetics	1	0	1	8.3	21
Availability	0	1	1	8.3	21
Arbitration and disputes	1	0	1	8.3	21
Familiarity of the system	1	0	1	8.3	21
Market competition	1	0	1	8.3	21
Product range	0	1	1	8.3	21
Reduce client staffing	0	1	1	8.3	21
Responsibility	0	1	1	8.3	21
Sales channel	0	0	0	0	30

Table 5: Round Two - Average score (Si) of each PP method

Project Procurement (PP) method	**Average score (Si) of each PP method**				
	Product quality	Capability	Price competition	Flexibility	Speed
i) In-house Design and Construct	4.5	3.42	3.58	4.08	3.5
ii) In-house Design and Develop	4.5	3.5	3.25	4	3.33
iii) Design separated from Construction	4.33	3.92	3.92	3.58	3.92
iv) Novation Contract	4.08	3.92	3.42	3.42	3.75
v) Design and Construct	3.92	4	3.25	3.33	3.92
vi) Design and Develop by Consultant	4.08	3.25	3.25	3.17	3.58
vii) Off-shelf Sourcing	2.83	2.92	4.67	2.08	4.33

Table 6: **Round Four – Criteria weight (Wi) for three generic types of project development**

Selection Criteria for PP methods	**Criteria weight (Wi) for three generic types of project development**		
	First type used commercially	Major functional improvements	Minor functional improvements
Product quality	***0.33***	***0.28***	0.17
Capability	0.28	0.24	0.16
Price competition	0.11	0.18	***0.37***
Flexibility	0.16	0.16	0.1
Speed	0.12	0.14	0.2

Table 7: **Round Four – Final score (S) of each PP method for "First type used commercially"**

PP method	$s_i w_i$					Total score (S) = $\sum_{i=1}^{5} s_i w_i$	Rank
	Product quality (w_i =0.33)	Capability (w_i =0.28)	Price competition (w_i =0.11)	Flexibility (w_i =0.16)	Speed (w_i = 0.12)		
i) In-house Design and Construct	1.49	0.96	0.39	0.65	0.41	3.9	2
ii) In-house Design and Develop	1.49	0.98	0.34	0.63	0.39	3.83	3
iii) Design separated from Construction	1.43	1.1	0.41	0.59	0.43	3.96	1
iv) Novation Contract	1.35	1.1	0.36	0.53	0.43	3.77	4
v) Design and Construct	1.26	1.12	0.39	0.53	0.46	3.76	5
vi) Design and Develop by Consultant	1.32	0.96	0.35	0.51	0.42	3.56	6
vii) Off-shelf Sourcing	0.85	0.82	0.52	0.33	0.51	3.03	7

Table 8: **Round Four – Final score (S) of each PP method for "Major functional improvements"**

PP method	$S_i W_i$					**Total score (S)** = $\sum_{i=1}^{5} S_i W_i$	**Rank**
	Product quality (W_i =0.28)	Capability (W_i = 0.24)	Price competition (W_i =0.18)	Flexibility (W_i = 0.16)	Speed (W_i = 0.14)		
i) In-house Design and Construct	1.26	0.82	0.64	0.65	0.48	3.85	2
ii) In-house Design and Develop	1.26	0.84	0.55	0.63	0.46	3.74	3
iii) Design separated from Construction	1.21	0.94	0.68	0.59	0.5	3.92	1
iv) Novation Contract	1.14	0.94	0.59	0.53	0.5	3.7	5
v) Design and Construct	1.07	0.96	0.63	0.53	0.54	3.73	4
vi) Design and Develop by Consultant	1.12	0.82	0.57	0.51	0.49	3.51	6
vii) Off-shelf Sourcing	0.72	0.7	0.86	0.33	0.6	3.21	7

Table 9: **Round Four – Final score (S) of each PP method for "Minor functional improvements"**

PP method	$s_i w_i$					**Total score (S)** = $\sum_{i=1}^{5} s_i w_i$	Rank
	Product quality (w_i =0.17)	Capability (w_i = 0.16)	Price competition (w_i =0.37)	Flexibility (w_i =0.1)	Speed (w_i = 0.2)		
i) In-house Design and Construct	0.77	0.55	1.32	0.41	0.68	3.73	2
ii) In-house Design and Develop	0.77	0.56	1.14	0.39	0.65	3.51	6
iii) Design separated from Construction	0.74	0.63	1.39	0.37	0.72	3.85	1
iv) Novation Contract	0.69	0.63	1.2	0.33	0.72	3.57	5
v) Design and Construct	0.65	0.64	1.3	0.33	0.77	3.69	4
vi) Design and Develop by Consultant	0.68	0.55	1.17	0.32	0.7	3.42	7
vii) Off-shelf Sourcing	0.44	0.47	1.76	0.21	0.85	3.73	2

	Product design		Development	Manufacture
	Preliminary	**Final**		
i	**In-house Design and Construct (IDC)**: Product design, Development and Manufacture by Client			
	Client			
ii	**In-house Design and Develop (IDD)**: Product design and Development by Client; Manufacture by OEM supplier			
	Client			**OEM supplier**
iii	**Design separated from Construction (DsfC)**: Product design by Client; Development and Manufacture by OEM supplier			
	Client		**OEM supplier**	
iv	**Novation Contract (NC)**: Preliminary Product design by Client's employed designer, whose contract is then transferred to the OEM supplier that work together to complete the Final Product design, Development and Manufacture			
	Client	**OEM supplier**		
v	**Design and Construct (DC)**: Product design, Development and Manufacture by ODM supplier			
	ODM supplier			
vi	**Design and Develop by Consultant (DDC)**: Product design by Design consultant who subcontracts manufacture to the third party supplier			
	Design consultant			**Third party supplier**
vii	**Off-shelf Sourcing (OS)**: Source and buy existing products, for instance, from ODM suppliers			
	Product design, Development not required			**ODM supplier**

Figure 1: Classification of PP methods in terms of Design, Develop and Manufacture

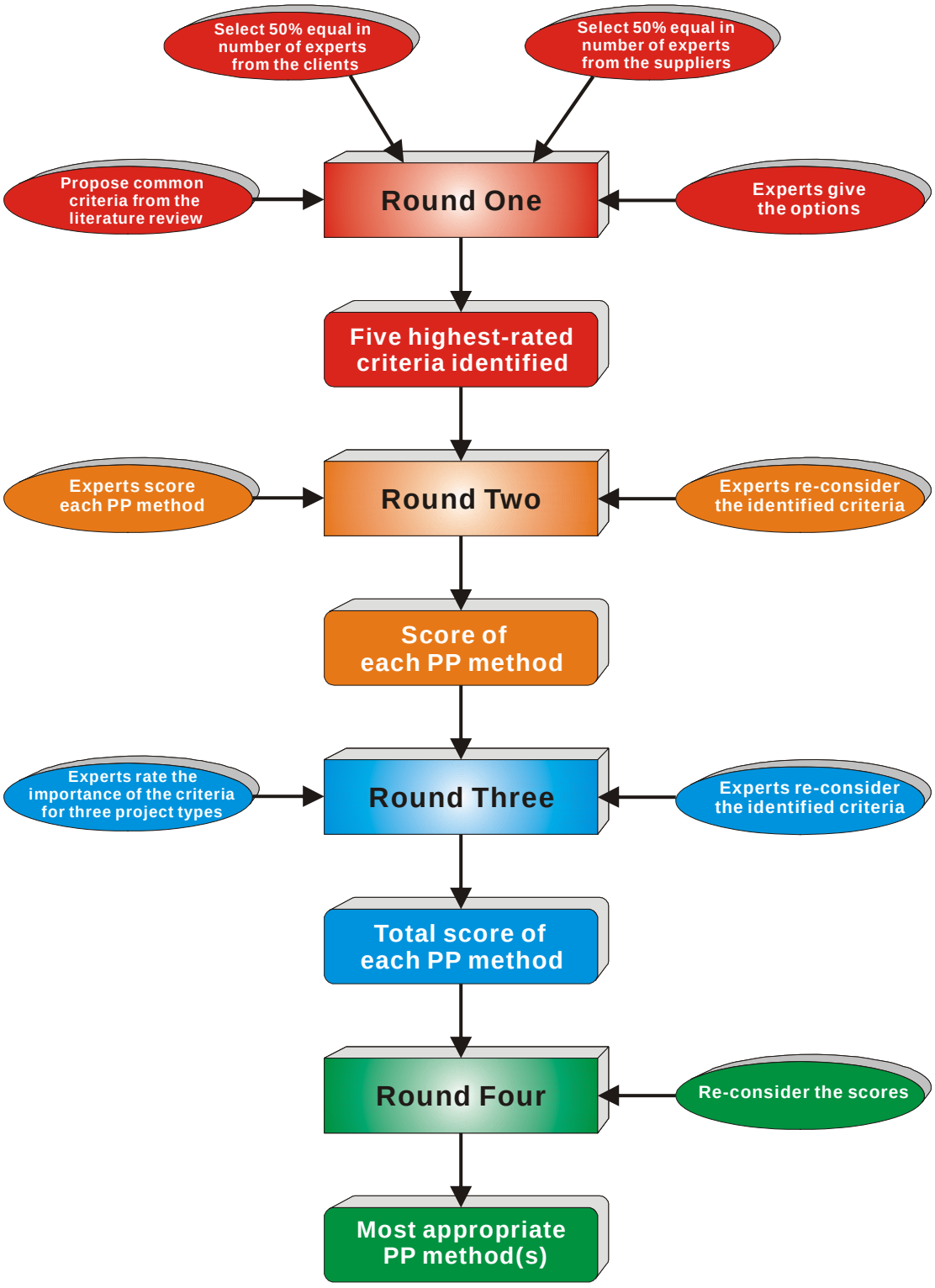

Figure 2: Structure of the 4 Rounds Delphi Questionnaire Survey

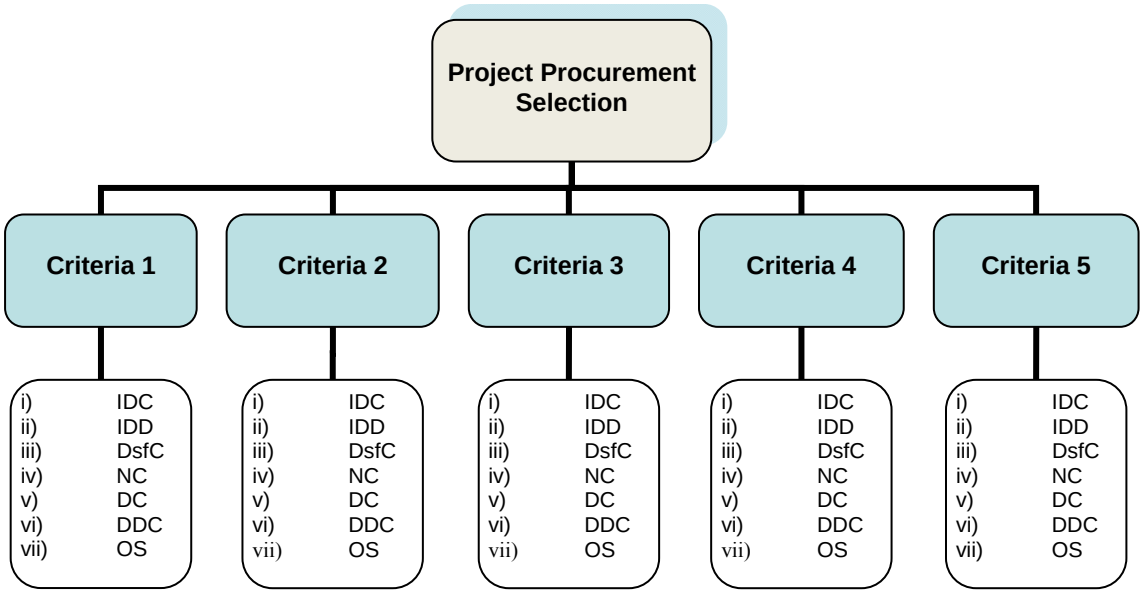

Figure 3: AHP hierarchy for selecting the most appropriate PP method

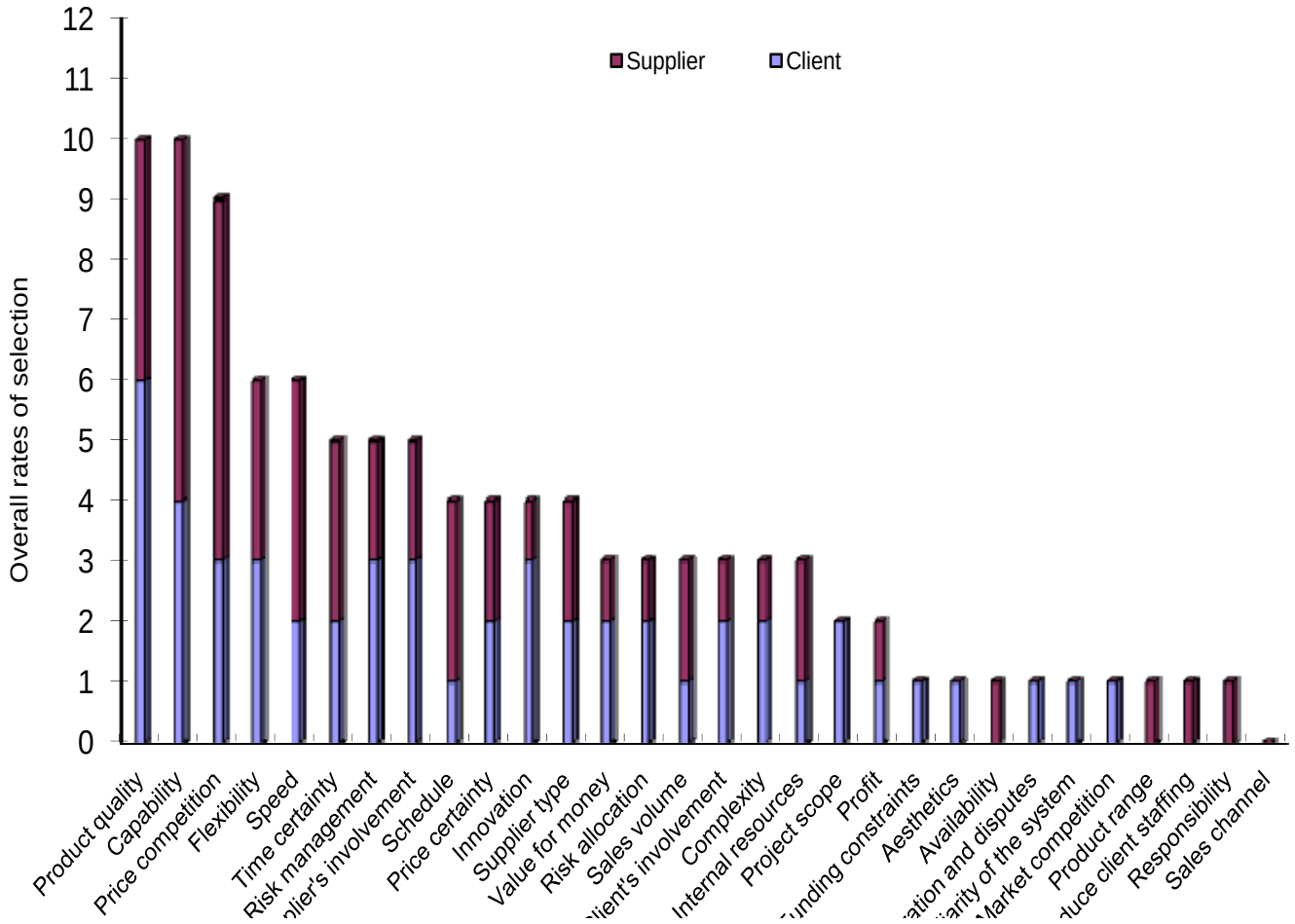

Figure 4: Round One – Overall rates of selection on the criteria

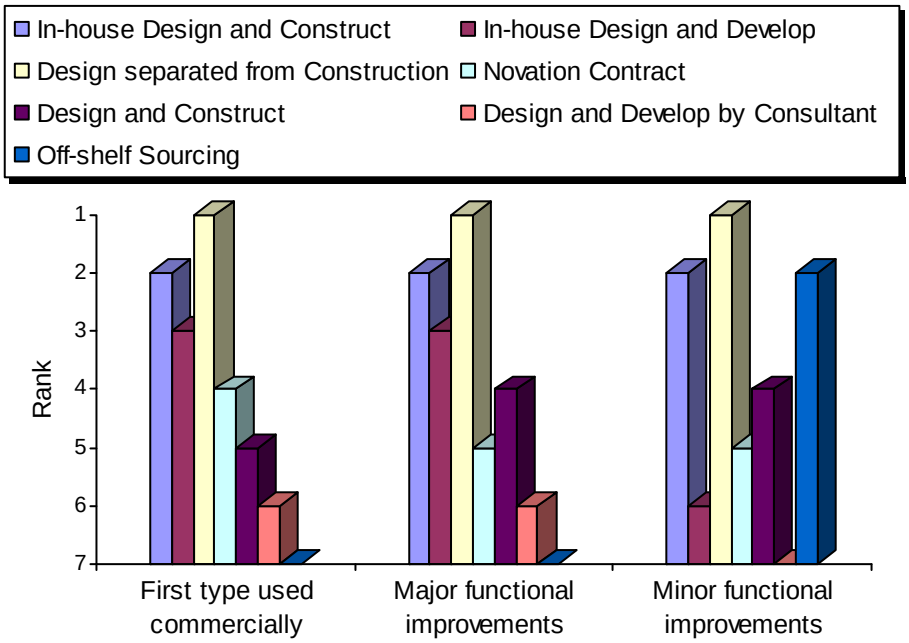

Figure 5: Overall ranking of project procurement methods to each type of project in consumer electronics industry

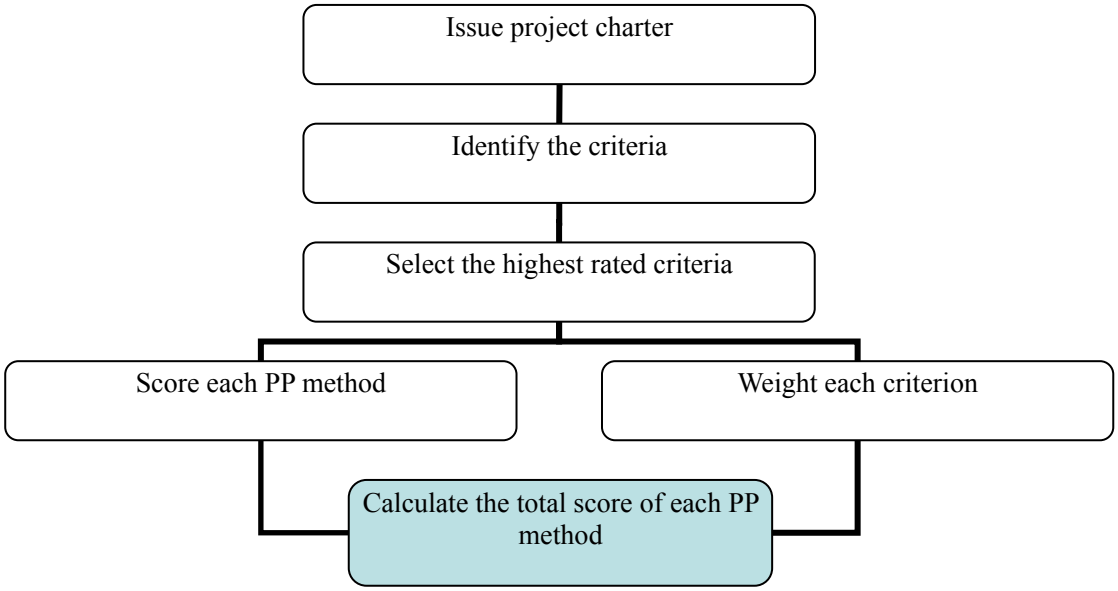

Figure 6: Guideline to determine the most appropriate PP method